REMARKS

In the above-identified Office Action the Examiner has rejected claims 1-9 as indefinite for use of the term "critical value". Applicant has amended the claims to better define this term and, as amended, believes that the claims are now definite under 35 USC Section 112.

Claims 17-20 have been rejected as indefinite for the description of a plane in cubic terms. Applicant has cancelled claims 17, 18 and 20 so this rejection is considered obviated as to those claims. Claim 19 does not have the objected to phrase and, accordingly, it is believed that claim 19 is acceptable as it stands.

Claims 1 and 4 have been rejected under 35 USC Section 102(b) as anticipated by Okui. Applicant has amended claims 1 and 4 so that it believes it now recites over Okui. The invention of claims 1 and 4 was made on the basis of the inventor's discovery as described in the specification page 44, lines 12-16. That is, when a solid-liquid interface shape is convex upward, G_l distribution in a wafer plane is uniform at or above a certain level, and radial distribution of V/G_l is uniform at or above a certain level. Accordingly, it is possible to prevent an occurrence of the R-OSF at an outer periphery of an ingot, even when V/G_l of the center of the ingot is decreased to near the critical value (See FIG. 7 (c)).

Therefore, according to the invention of claim 1, a convex shape with respect to the solid-liquid interface makes it possible to produce an ingot containing no R-OSF in the entire wafer, even when V/G_l is decreased to near the critical value. Further, according to the invention of claim 1, the size of the void defect becomes small, since V/G_l can be decreased to near the critical value. Furthermore, according to the invention of claim 1, a degradation of the productivity is preventable since V can be increased together with G_l to keep V/G_l small.

Meanwhile, Okui (US6,458,204) discloses a configuration "a solid liquid interface....is convex with respect to the melt surface" set forth in claim 1 of the instant invention.

However, Okui does not disclose the method (amended) in claim 1, "pulling the silicon crystal while keeping a growth condition V/G_l within the range of near a critical value, in a state in which the axial temperature gradient G_l near the melting point of the silicon crystal is increased and a solid-liquid interface, which is a boundary between the silicon crystal and the melt during the pulling of the silicon crystal is

convex with respect to the melt surface."

Primarily, Okui is directed to produce a defect-free crystal, unlike the instant invention in claim 1 that is directed to produce a crystal containing void defects. Therefore, Okui does not suggest the instant invention of claim 1. Accordingly, it is believed claims 1 and 4 define over Okui.

The Examiner has also rejected claims 10-16 as being anticipated by Inagaki et al. Applicant has cancelled claims 10, and 11-12 and has changed the dependencies of claims 13-16 and, accordingly, this rejected is considered obviated.

Claims 17-18 have been rejected as anticipated by Nakamura. Claims 17 and 18 have been cancelled and, accordingly, this rejection is considered obviated.

Claims 2-3 and 5-6 have been rejected over Okui et al as applied to claims 1 and 4 and further in view of Inagaki. Claims 2, 3 and 5 are dependent from claim 1 which applicant believes to be patentable as set forth above. Clearly, these claims should also be patentable.

Claim 6 – First, as for the phrase "near a critical value" recited in claim 6, the range of this value is defined by the range of "near a critical value" defined in claim 1, a critical value per se and the range where an R-OSF region does not exist in a plane of a silicon wafer at least from a center of the plane up to 10 mm from an outer periphery in the silicon wafer (See FIG. 2, slightly left region from the critical value).

The invention in claim 6 is similar to claim 1, except for the point that claim 6 allows a wafer to include the R-OSF (an OSF nucleus) in the region between the outer periphery and 10 mm from the outer periphery. Meanwhile, a step "a cooler is used to cool the silicon crystal" recited in claim 6 is related to that recited in claim 1, namely, "in a state in which a solid-liquid interface, which is a boundary between the silicon crystal and the melt during the pulling of the silicon crystal, is convex with respect to the melt surface."

Generally, it is undesirable to contain the R-OSF in the silicon wafer, and therefore the invention in claim 1 is directed not to contain the OSF nucleus which materializes to the R-OSF. However, as described in the specification page 53, lines 14-22, even if an OSF nucleus exists in the silicon wafer, there is no problem if the OSF nuclei does not materialize to the OSF. Accordingly, the invention of claim 6 allows the wafer to contain the OSF nuclei. By the inventions in Claims 7,8 the OSF nucleus does not materialize to the R-OSF.

According to the invention in claim 6, though there is a possibility of containing OSF nuclei at the outer periphery because V/G_1 is controlled near the critical value it is able to gain the same effect of claim 1.

On the other hand, as mentioned in the above item (1), in Okui, there is no concept of controlling V/G_1 at "near the critical value". Further, while Inagaki (US 2002/0144641) discloses a technique to use cooler temperatures, however there is no concept of controlling V/G_1 at "near the critical value".

Claims 7-9 and 17-18 have been rejected as unpatentable over Okui et all in view of Inagaki and further in view of Akiyama. Claims 7-9 depend from claim 6 which, as amended, is patentable as set forth above. Claims 17-18 have been cancelled and, accordingly, this rejection is considered obviated.

Claims 17-18 have also been rejected over Okui in view of Akiyama. As claims 17-18 have been cancelled as stated above, this rejected is considered obviated.

Claims 17-20 have been rejected as unpatentable over Nakamura in view of Falster. Claims 17, 18 and 20 have been cancelled. Accordingly, as to those claims those rejections are considered obviated.

Regarding claim 19, as described in the specification page 27, lines 5-10, the invention in claim 19 is made on the basis of the discovery that "the occurrence of dislocation clusters is suppressed by lowering the carbon concentration in a silicon single crystal to below the conventional level: and "when the carbon concentration is reduced to a certain level, there is a sharp decrease in the occurrence of dislocation clusters, and the allowable range for the growth condition V/G under which defect-free crystals can be obtained is sharply expanded". Nakamura (US 6,869,478) discloses a defect-free crystal, however, there is no teaching about relationships between the carbon concentration and the dislocation cluster. Falster (US 2002/0121238) discloses that carbon acts as an oxygen precipitate nuclei catalysis. However, there is no teaching about relationships between the carbon concentration and the dislocation clusters.

As a result claim 19 is considered patentable over the combination of Nakamura and Falster.

Claim 21 has been rejected as unpatentable over Holder et al in view of Everts. The invention in claim 21 corresponds to an embodiment of claim 19. As shown in FIGS. 30-35, the carbon concentration can be changed by adjusting the height of a heat shield. Neither Holder (US 6,039,801) nor Everts (US

5,443,034) discloses the technique to control carbon concentration by adjusting the height of the heat shield.

Applicant hereby requests reconsideration and re-examination thereof.

With the above amendments and remarks applicant hereby requests an early notice of allowance. Should the Examiner be of the opinion that a telephone conference would expedite prosecution of the subject application he is respectfully requested to call the undersigned at the below-listed number.

Respectfully submitted,

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